System Engineered Instrument

D/374

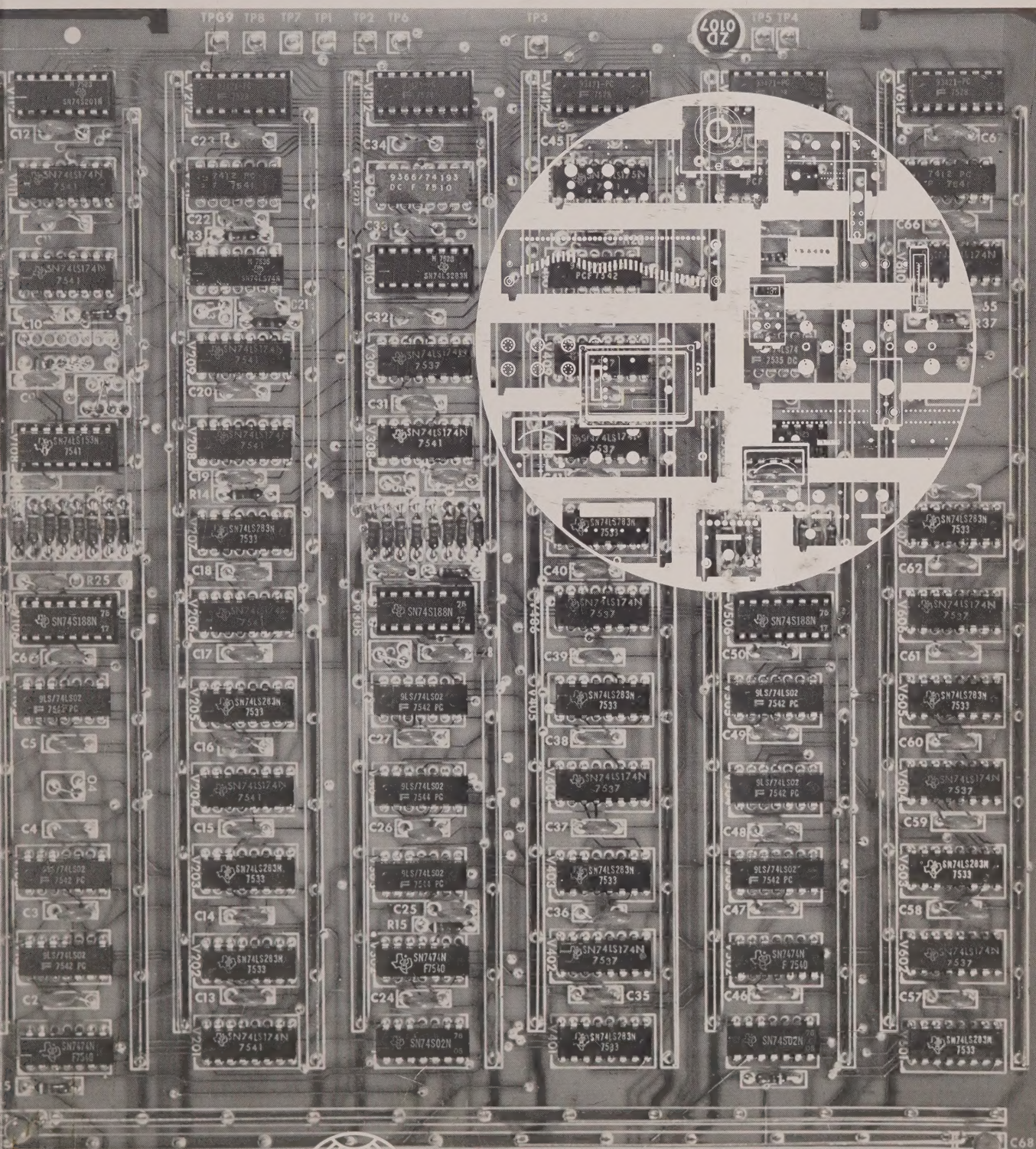
W.F. Wood

Instruction Manual

Instruction Manual

1/12 Octave Controller

Type 5788



Brüel & Kjær

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Instruction Manual

1/12 Octave Controller

Type 5788

BRÜEL & KJÆR

D/374

W.F. Wood

Revised September 1979.

Apparatus for teletechnical, acoustical and vibrational research

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D/374
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BRÜEL & KJÆR

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BRÜEL & KJÆR system development

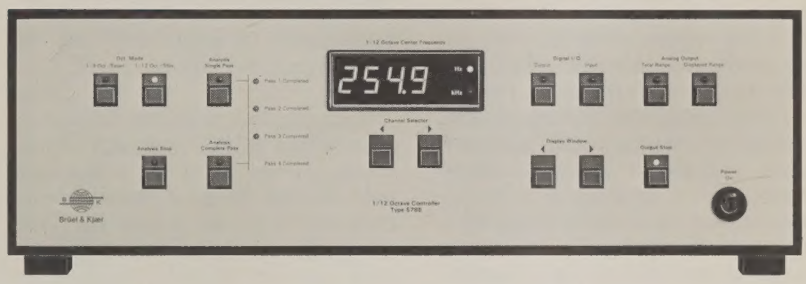
type 5788

D/374

W. F. Wood

1/12 Octave Controller

for use with Digital Frequency Analyzer Type 2131



FEATURES:

- Controls Digital Frequency Analyzer Type 2131 in 1/12 octave analysis from 1,41 Hz to 21,75 kHz
- Controls display of 1/12 octave spectrum on 2131 display screen
- IEC interface and controller function built-in with 2131 and up to 2 peripherals addressable from the 5788
- Controls digital read-in and read-out of 1/12 octave spectrum over IEC interface
- Alphanumeric read-out of channel centre frequency (from 5788) and level (from 2131)
- Allows analog read-out of 1/12 octave spectrum

USES:

- Control of the 2131 in 1/12 octave analysis
- As IEC controller in system consisting of 2131 and up to 2 peripherals
- 1/12 octave analysis (with 2131) of continuous and impulsive signals

Introduction

The main function of the 1/12 Octave Controller Type 5788 is the control of the Digital Frequency Analyzer Type 2131 in a 1/12 octave analysis. Its other functions include control of the 1/12 octave spectrum display on the display screen of the 2131, together with the read-out of the entire spectrum in a digital manner to an IEC-compatible peripheral such as a digital cassette recorder or alphanumeric printer, etc., or in an analog manner to an X—Y or level recorder.

1/12 octave analysis is possible using the 2131/5788 because operation of the 2131 is based on digital filtering. One of the greatest advantages of this technique is that the filter characteristics obtained are dependent on coefficients using in the filtering process (and also the sampling frequency), rather than the components making up the filter network, (see 2131 data sheet). Hence, by using different sets of these filter coefficients, the same digital filter network can be made to generate many different filter characteristics.

This property allows the Digital Frequency Analyzer Type 2131, principally designed for octave and 1/3 octave analysis, to be controlled in an additional 1/12 octave mode. The filter coefficients required for this are already stored in the 2131, and it is only a matter of accessing these coefficients in the correct manner to obtain 1/12 octave analysis.

The processing speed of the 2131 is such that when operating

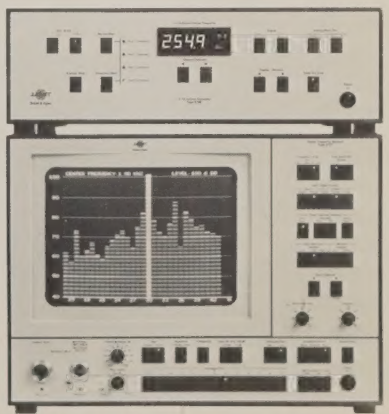


Fig.1. 5788/2131 combination for 1/12 octave analysis

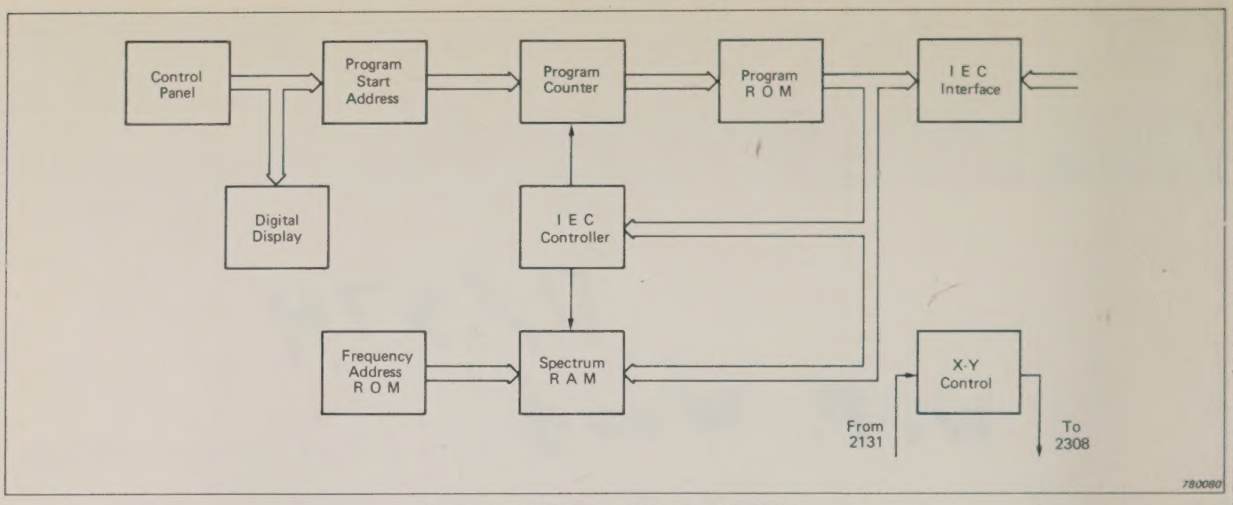


Fig.2. Simplified block diagram of the 5788

in 1/12 octave mode, 3 1/12 octaves within each octave of the analysis range, (1,41 Hz to 21,75 kHz), can be obtained simultaneously. Hence, in order to obtain the complete analysis, 4 passes must be made, with a different 3 1/12 octaves within each octave being measured with each pass. The final stage of the operation is to assemble the information obtained in the correct order and so obtain the complete 1/12 octave spectrum.

Description

Type 5788 is basically an IEC Bus controller for the control of the 1/12 octave analysis in the 2131. It generates the necessary control signals and transmits them to the 2131 over the IEC Bus.

Fig.2 shows a simplified block diagram of the 5788. Operation of the 5788 is under control of a program held in the Program ROM, (Read Only Memory). On command from the 5788 front panel controls, the start address of this program is loaded into the Program Counter. This causes the program to start, whereby the instructions necessary to begin the first step of the analysis are transmitted over the IEC Bus. The IEC Controller waits until this step is completed before beginning the next. At no stage in the analysis process can a new step be started before the previous one is complete.

In order to obtain a 1/12 octave analysis from the 2131, it is not only necessary to generate the control signals required, but also to store the data obtained, since the 2131 does not have sufficient memory capacity. This is the purpose of the Spectrum RAM, (Random Access Memory), into which each successive stage of the analysis is entered, for assembly of the complete spectrum. The Frequency Address ROM ensures assembly in the correct order. When the analysis is complete, the spectrum may be read to the 2131 for display.

Filter Characteristics

The 1/12 octave filters generated using the 5788/2131 are 6-pole filters. A typical 1/12 octave filter

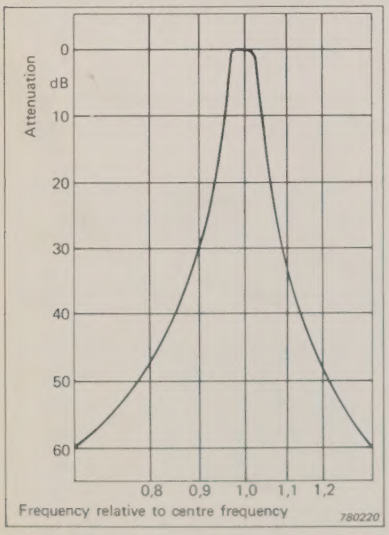


Fig.3. Typical 1/12 octave filter characteristic of the 5788/2131 combination

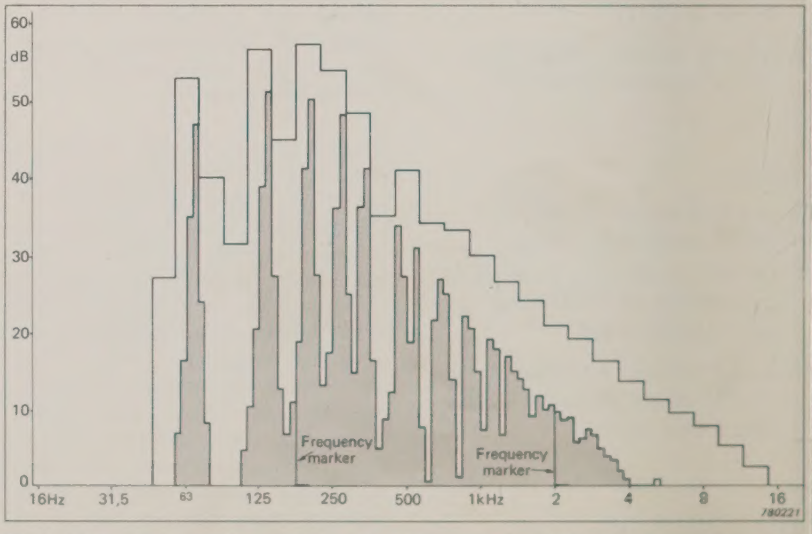


Fig.4. 1/12 octave analysis recorded on X—Y Recorder Type 2308. As a comparison, a 1/3 octave analysis of the same signal, (with 10 dB difference to aid comparison), is superimposed

Channel No.	1/3 Octave	Octave	Centre Frequency, Hz 1/12 Octave 1st Pass	2nd Pass	3rd Pass	4th Pass
2		1,6	2,370	1,991	1,675	1,410
3	2	2	2,506	2,109	1,774	1,493
4		2,5	2,655	2,230	1,879	1,581
5		3,15	4,730	3,982	3,351	2,820
6	4	4	5,013	4,218	3,549	2,986
7		5	5,311	4,470	3,759	3,163
8		6,3	9,470	7,965	6,702	5,640
9	8	8	10,03	8,437	7,099	5,972
10		10	10,62	8,940	7,519	6,327
11		12,5	18,93	15,93	13,40	11,28
12	16	16	20,05	16,87	14,20	11,95
13		20	21,24	17,87	15,04	12,65
14		25	37,86	31,86	26,81	22,55
15	31,5	31,5	40,11	33,75	28,40	23,89
16		40	42,49	35,75	30,08	25,31
17		50	75,70	63,72	53,62	45,11
18	63	63	80,22	67,50	56,79	47,78
19		80	84,98	71,50	60,16	50,62
20		100	151,5	127,4	107,2	90,22
21	125	125	160,4	135,0	113,6	95,56
22		160	170,0	143,0	120,3	101,2
23		200	302,9	254,9	214,5	180,4
24	250	250	320,9	270,0	227,2	191,1
25		315	339,9	286,0	240,6	202,5
26		400	605,8	509,8	428,9	360,9
27	500	500	641,8	540,0	454,3	382,3
28		630	679,8	572,0	481,3	404,9
29		800	1,212 k	1,019 k	857,9	721,8
30	1 k	1 k	1,283 k	1,079 k	908,7	764,5
31		1,25 k	1,359 k	1,144 k	962,5	809,9
32		1,6 k	2,423 k	2,039 k	1,715 k	1,443 k
33	2 k	2 k	2,567 k	2,159 k	1,817 k	1,529 k
34		2,5 k	2,719 k	2,288 k	1,925 k	1,619 k
35		3,15 k	4,847 k	4,078 k	3,431 k	2,887 k
36	4 k	4 k	5,134 k	4,319 k	3,634 k	3,058 k
37		5 k	5,438 k	4,576 k	3,850 k	3,239 k
38		6,3 k	9,694 k	8,156 k	6,863 k	5,774 k
39	8 k	8 k	10,27 k	8,639 k	7,269 k	6,116 k
40		10 k	10,88 k	9,152 k	7,700 k	6,479 k
41		12,5 k	19,39 k	16,31 k	13,73 k	11,55 k
42	16 k	16 k	20,54 k	17,28 k	14,54 k	12,23 k
43		20 k	21,75 k	18,30 k	15,40 k	12,96 k

Table 1. Centre frequencies of 2131 filters

characteristic obtained from them is shown in Fig.3. (For the octave and 1/3 octave filter characteristics of the 2131, see the 2131 data sheet). Table 1 gives the centre frequencies of the 168 1/12 octave filters generated.

Since the analysis is sequential in 4 passes, sufficient time must be allowed between each pass in order that the filters can stabilize and give accurate measurements. This delay, which becomes progressively longer as analysis is required to lower and lower frequencies, is selectable according to the lowest frequency of interest via the 5788 rear panel controls. Should, when the analysis is completed, the Channel Selector be set to a 1/12 octave channel where the delay was insufficient, the decimal point of the 1/12 Octave Centre Frequency display will flash to warn of possible measurement error. Note that when the selected averaging time becomes long with respect to the required delay, then the choice of the time delay has little influence on the overall measurement accuracy.

1/12 Octave Analysis and Display

The four passes of the 1/12 octave analysis may be controlled manually or automatically. Manual control permits a pause to be introduced between each pass, allowing, e.g., the rewind of a tape recorder. The tape can then be restarted from the same point for each pass, allowing the same section of signal to be analyzed each time. The start of each pass can be triggered either manually via the 5788 front panel controls, or externally from a 1 kHz tone bust, e.g., recorded on another track of the tape. When under automatic control, the 5788 runs through all four passes of the analysis without stopping. This may be used with stationary signals.

The total analysis time depends on the averaging time selected on the 2131 and the time delay between passes selected on the 5788, (see Filter Characteristics Section). The total time will be 4 times the sum of the two.

On completion of the analysis, 30 contiguous channels of the 168 channel spectrum will be displayed on the 2131 display screen. This display window can be shifted backwards and forwards across the 168 channels in octave steps. The Channel Selector may be used to read the level (from the 2131), and the centre frequency (from the 5788), of any displayed channel.

Analog Read-out

An analog read-out of all or part of the 1/12 octave spectrum can be made either to a Level Recorder Type 2307 or to an X—Y Recorder Type 2308. For read-out to a 2307, the output and control signals are taken from the 2131, although over-

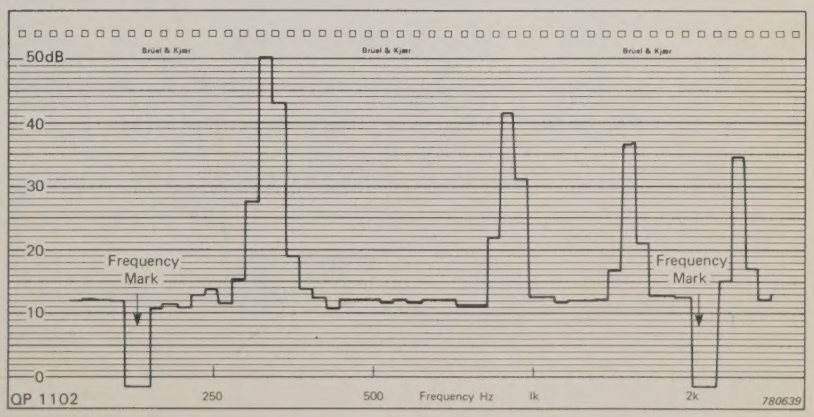


Fig.5. Part of 1/12 octave analysis recorded with a Level Recorder Type 2307

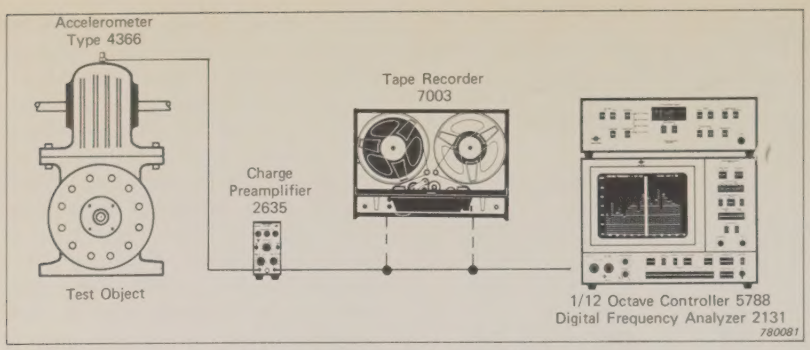


Fig.6. Set-up for condition monitoring

all control of the read-out process rests with the 5788. Read-out to a 2308 requires modification of the 2131 X—ramp. This occurs in the 5788, which then outputs both the X and Y signals.

Fig.s 4 and 5 show an X—Y and part of a Level Recorder read-out respectively. Frequency markers are placed in both after each 1/4 of the spectrum in order to aid its readability. These markers consist of a vertical line followed by a horizontal line 2 channels wide for an X—Y recorder, and a hole in the spectrum 2 channels wide for a level recorder.

Digital Input/Output

The IEC interface of the 5788 allows the digital input from and the digital output to other digital peripherals of spectra. Up to two IEC compatible peripherals, (or more when an external IEC interface bus controller is used), may be connected, e.g., a digital cassette recorder and an alphanumeric printer, allowing external storage of spectra, and the provision of documentation of data, respectively.

Applications

It is well known that the vibration spectrum of a machine gives an accurate indication of its overall running condition. The 2131/5788 combination illustrated in Fig.6 forms an effective means of obtaining that spectrum, allowing a wide frequency range to be covered in a single measurement with narrow bandwidth (6%). An advantage of using the 2131/5788 in such a measurement is that the spectrum is relatively immune to small changes in machine speed.

An Accelerometer Type 4366 is used to pick up the vibration signal, which is then input to a Charge Amplifier Type 2635. The output of the 2635, which can be in terms of acceleration, velocity or displacement is then analyzed using the 2131/5788. By comparing the results obtained with known limits, the machine might be allowed to continue operation, or shut down for repair, hence avoiding costly breakdowns.

Instead of making the analysis online, the vibration signal could be recorded, e.g., using a Tape Recorder Type 7003, and then later analyzed in the laboratory. Many such signals from many monitoring points could be recorded on a single reel of tape. The spectrum obtained from each monitoring point could then be compared with a reference, held either in digital form on a digital cassette recorder or as a hard copy read-out to an X—Y or Level Recorder, and the appropriate decisions made.

Specifications 5788

Filters:
168 6-pole filters

Bandwidth:
1/12 octave (approx. 6%)

Time Delay:
Selectable - the time delay is chosen as a function of the lowest frequency of interest as follows

Time Delay	Lowest Frequency of Interest
64s	1,41 Hz
4s	20 Hz
1s	80 Hz
1/8s	640 Hz
0s	for impulse measurements.

Frequency Range:
1,41 Hz to 21,75 kHz

Dynamic Range:
60 dB

Analysis:
4-pass automatic control or 4-pass manual control. In manual control, each pass can be started via the 5788 front panel controls or from an external trigger, (1 kHz tone burst, amplitude >100 mV.)

Channel Selector:
Allows alphanumeric read-out of channel centre frequency (from 5788) and level (from 2131)

Display Window:
30 contiguous channels of the 168 channel spectrum can be displayed at any one time. Display window selectable in octave steps.

Digital Input/Output:
IEC compatible, SH 1, AH 1, T 4, L 2, DC 1, C 2, C 28 functions incorporated.

Analog Outputs:
Level Recorder: as 2131
X—Y Output: output impedance 100Ω
X—Ramp: 0—10 V for 170 channels in 4 times the time required for an octave or 1/3 octave output.
Y-Level: as 2131

Power Supply:
100, 115, 127, 220, 240 V, ± 10%, 50 to 400 Hz, approx. 20 W
Fulfils IEC 348 Safety Class II

Dimensions (A Cabinet):
Height: 133 mm
Width: 430 mm
Depth: 320 mm

Accessories Supplied:
Mains cable AN 0020
IEC interface connecting cable AO 0129

Accessories Available:
BNC-BNC cable AO 0087
DIN cable AQ 0034 (2 necessary for X—Y recorder output).

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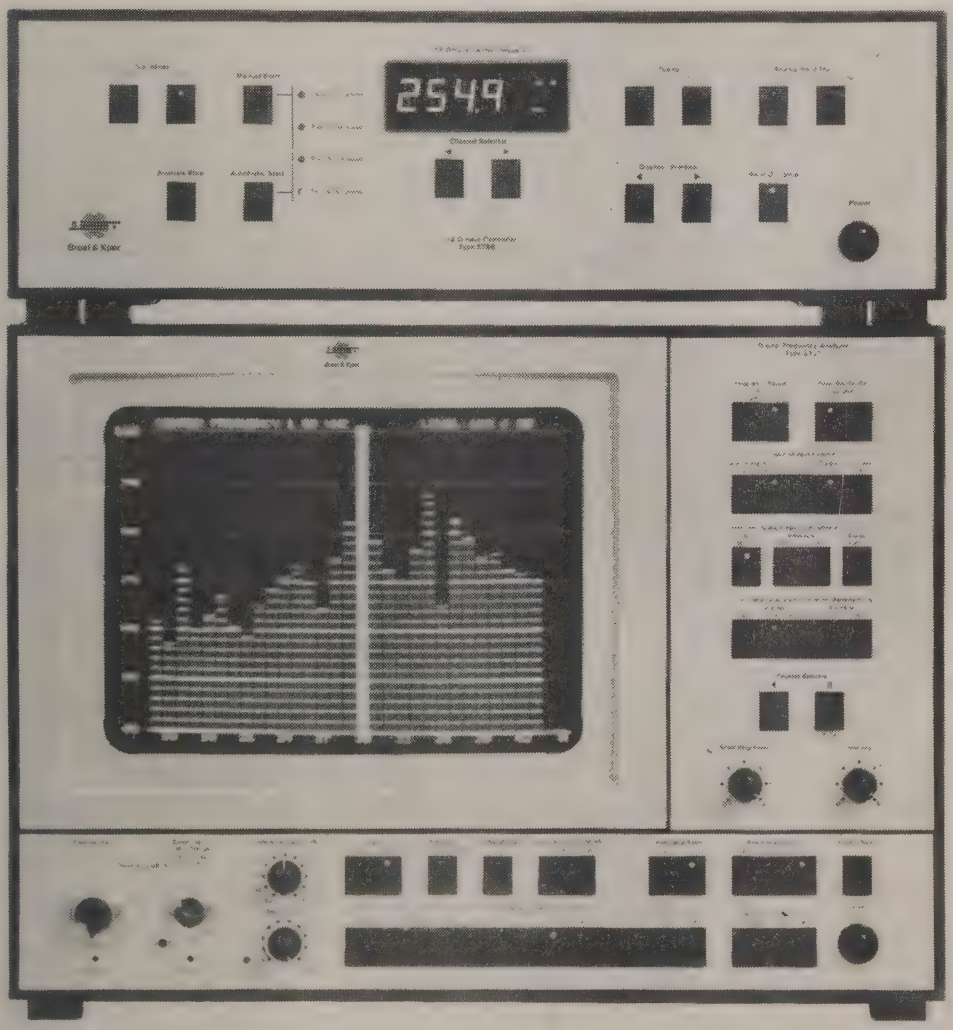
N O T E

A modification is necessary to earlier models of type 2131 if they are to be used with type 5788.

The modification is only applicable for type 2131 with serial numbers lower than ser. No. 723792 and entails the following:

1. Locate and withdraw printed circuit card ZD 0162
2. Remove 10 K ohm resistor at position R 51 and replace with 39 K ohm resistor
3. Replace ZD 0162



Type 5788 together with Type 2131.

Title 5788 ANALOG & DIGITAL INTERFACE DEVICES

Drawn DL/SHe Date 19.9.78 Drawing no. WW 2143

Brüel & Kjær
Copenhagen

1/12 Octave Controller Type 5788

Introduction

Type 5788 1/12 Octave Controller is an instrument designed for the control of Digital Frequency Analyzer Type 2131 in its 1/12 octave mode over an IEC bus system.

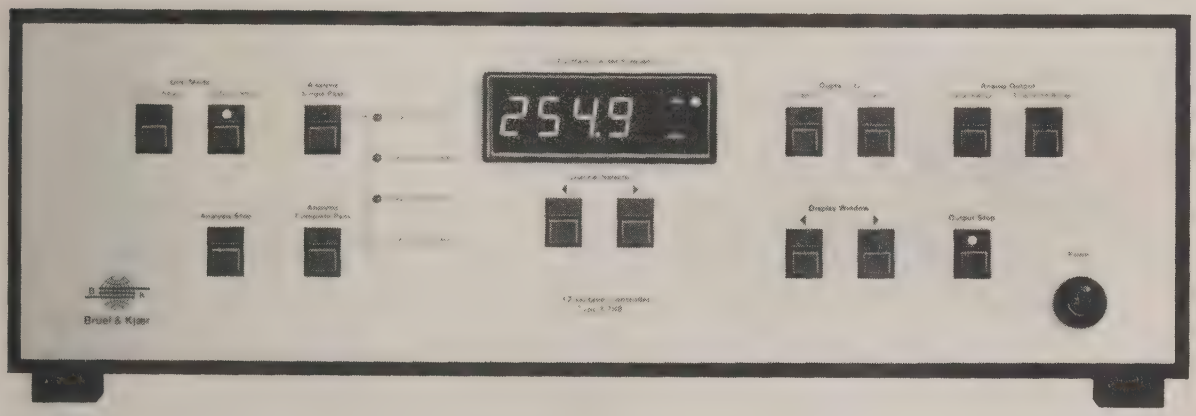
Operation of the Digital Frequency Analyzer Type 2131 is based on digital filtering. One of the greatest advantages of this technique is that the filter characteristics obtained are dependent on coefficients used in the filtering process (and also the sampling frequency), rather than components making up each filter network (see 2131 Instruction Manual). Hence, by using different sets of these filter coefficients, the same digital filter network can be made to generate many different filter characteristics.

This property allows the Digital Frequency Analyzer Type 2131, principally designed for octave and 1/3 octave analysis, to be controlled in an additional 1/12 octave mode. The filter coefficients required for this are already stored in the 2131, and it is only a matter of accessing these coefficients in the correct manner to obtain 1/12 octave analysis.

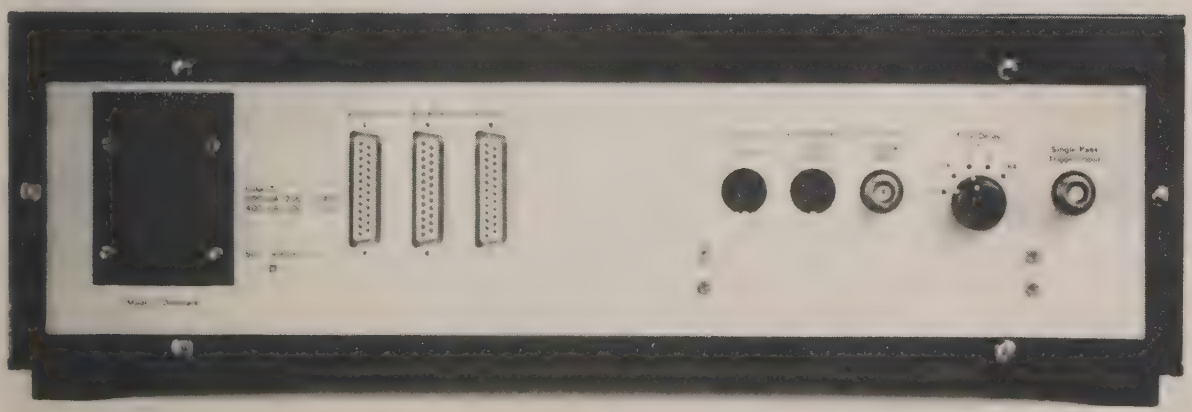
The processing speed of the 2131 is such that when operating in 1/12 octave mode, three 1/12 octaves within each octave of the analysis range (1.41 Hz to 21.75 Hz), can be obtained simultaneously. Hence, in order to obtain the complete analysis, four scans or passes must be made with a different three 1/12 octaves within each octave being measured with each pass. The final stage of the operation is to assemble the information obtained in the correct order and so obtain the complete 1/12 octave spectrum.

The two main functions of the 1/12 Octave Controller Type 5788 are the control of a 1/12 octave analysis and the assembly of the data obtained to form the 1/12 octave spectrum, as described above. Its other functions include control of the 1/12 octave spectrum display on the display screen of the 2131, together with the read-out of the spectrum in a digital manner to an IEC bus compatible peripheral such as a digital cassette recorder or alphanumeric printer, etc., or in an analog manner to an X - Y or level recorder.

1/12 Octave Controller Type 5788.

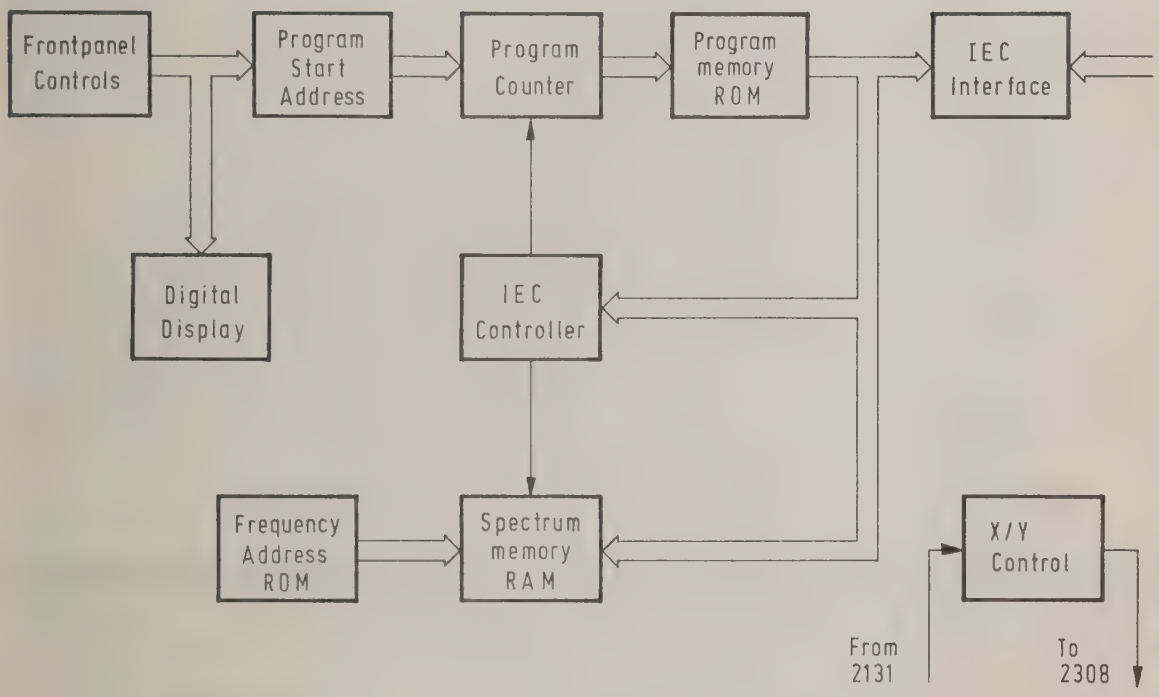


Type 5788 Front view.



Type 5788 Rear view.

Simplied Block Diagram of Type 5788



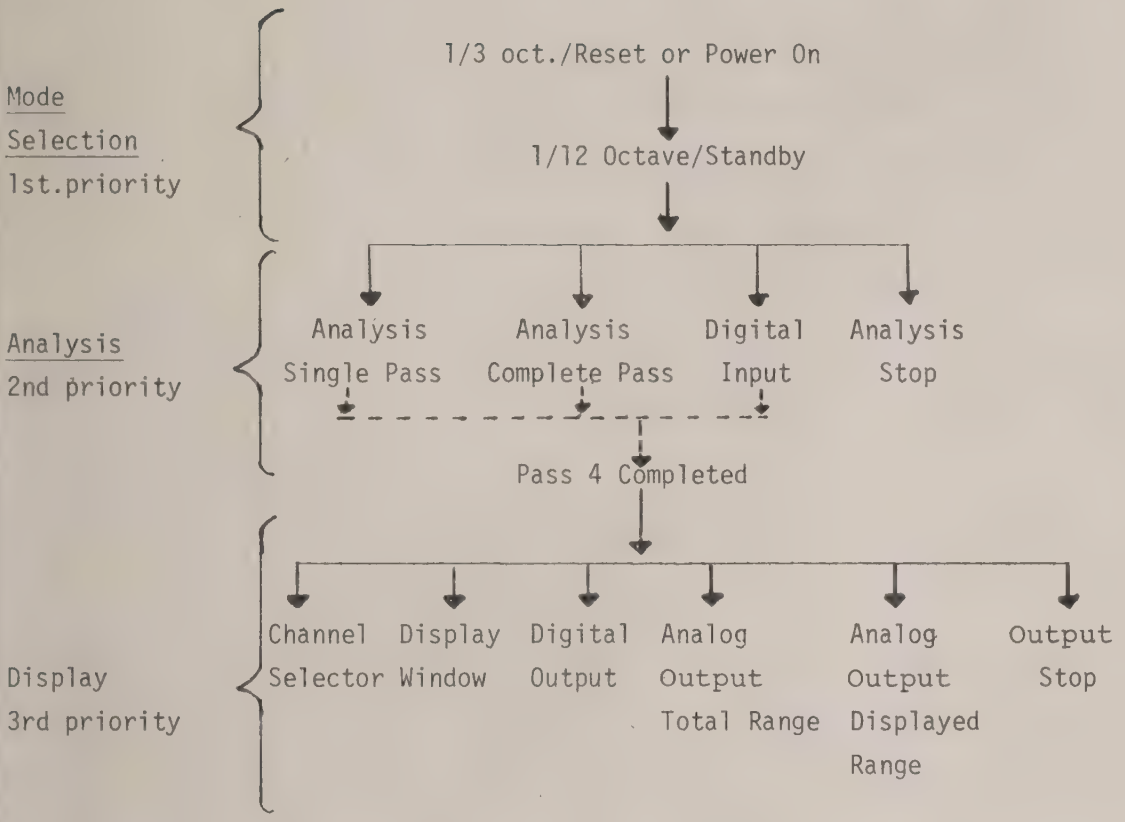
General Description

Type 5788 is basically an IEC bus controller (see specs. pages 13 & 25) for the control of the 1/12 octave analysis in the 2131. It generates the necessary control signals and transmits them to the 2131 over the IEC bus.

Fig. 1 shows a simplified block diagram of the 5788. Operation of the 5788 is under control of a program held in the Program ROM, (Read Only Memory). On command from the 5788 front panel controls, the start address of this program is loaded into the Program Counter. This causes the program to start, whereby the instructions necessary to begin the first step of the analysis are transmitted over the IEC bus. The IEC controller waits until this step is completed before beginning the next. At no stage in the analysis process can a new step be started before the previous one is completed unless interruupted by activating one of the following funtions: 1/3 Octave/Reset, 1/12 Octave/Stby. or either of the Stop pushbuttons.
In order to obtain a 1/12 octave analysis from the 2131, it is not only necessary to generate the control signals required, but also to store the data obtained, since the 2131 does not have sufficient memory capacity. This is the purpose of the Spectrum RAM (Random Access Memory), into which each successive stage of the analysis is entered for assembly of the complete spectrum. The Frequency Address ROM ensures assembly in the correct order. When the analysis is complete, the spectrum may be read to the 2131 for display.

Pushbutton priority

Type 5788 front panel pushbuttons are devided into three groups with their respective priority as shown in the diagram below.



From the above diagram it can be seen that the 1/12 Octave/Standby mode must be selected, indicated by its lamp, before 1/12 oct. analysis (2nd priority) can take place. Likewise, "Pass 4 Completed" lamp must be on, indicating 1/12 oct. analysis complete, before it is possible to activate the display and read out pushbutton group (3rd priority)

Front Panel Controls and Display

Power On — On switching ON, the system performs a 1/3 octave/ Reset pushbutton function. Power ON is indicated by either 1/3 oct./Reset or 1/12 oct./Stby lamps being on.

1/3 Oct./Reset — This pushbutton has two functions:
(i) to System Reset type 2131 and interface system
NOTE that 3 seconds should be allowed for the re-setting procedure of type 2131 before activating any other pushbutton function.

(ii) to set 2131 in its normal mode of operation; and at the same time setting the interface system, such that either 2131 digital input or output can be used to an external device (e.g. digital tape recorder or printer), over the IEC bus. Whether digital input or output is operative is shown by 1 (input) or 0 (output) on the 5788 display.
To change between the digital input/output go to 1/12 octave/Stby and back again.

1/12 Octave/Stby — This pushbutton also has two functions:
(i) to prepare the system for 1/12 octave analysis
Note: The 2131 Averaging Time must be selected before continuing with the analysis.
(ii) to set 5788 in an inactive or standby state with respect to the rest of the system. This enables other devices' front panel controls that may have been locked (disabled) due to IEC bus activity.

Analysis Single Pass — Single pass analysis pushbutton enables a pause to be introduced between each of the 4 analyzing passes, allowing, e.g. the rewind of a tape recorder. The tape can then be restarted from the same point for each pass, allowing the same section of signal to be analyzed each time. The start of each pass can be triggered manually by this pushbutton or externally via the "Single Pass Trigger Input" socket, see details of rear panel sockets. The analysis is complete when "Pass 4 completed" lamp lights and a 1/12 octave window is then displayed on 2131 display screen.

Analysis Complete Pass — This function is used for analyzing stationary signals, where the four passes necessary for 1/12 octave analysis are carried out automatically. The analysis is completed when "Pass 4 completed" lamp lights and a 1/12 octave window is displayed on 2131 screen.

Analysis Stop

Used to stop an analysis being performed before pass 4 is completed. After Analysis Stop is activated a new analysis must be started from the beginning by first reverting to the 1/12 Oct./Reset function. The analysis may now be started again by selecting Single or Complete Pass Analysis.

Digital Input

With 1/12 Oct./Stby.lamp on, this function can initiate a digital data spectrum transfer from a peripheral, e.g. digital tape recorder into 5788 Spectrum RAM (Read Only Memory) over the IEC bus. The peripheral must be set to the listener/talker addresses given on page 26 . On completion "Pass 4 Completed" lamp lights enabling 5788 display controls.

Digital Output

Digital values for the total analysis range are transmitted to a digital interface peripheral set to the correct listener address, see page 26 .

Channel Selector

These two pushbuttons control the movement of the selected channel, either to the left or right. The selected channel is intensified with respect to the rest of the 2131 display screen. The 1/12 octave amplitude can be read alphanumerically on the screen, whereas the center frequency is indicated numerically on 5788 front panel. For flashing decimal point see page 10.

Note 1. The alphanumeric center frequency on 2131 screen must be ignored at all times whilst in 1/12 octave mode. Pushing a "Channel Selector" pushbutton once advances the selected channel one channel in the respective direction. Continued pressure produces a continuous movement.

Note 2. 2131 "Channel Selector" pushbuttons are inhibited whilst 5788 is in 1/12 octave mode unless 2131 is manually operated in certain pushbutton configurations.

Display Window	The 3o contiguous channels displayed on the 2131 screen are referred to as the window. The displayed window can be moved up or down the frequency range in octave steps over the complete analyzed range. Continued pressure produces a continuous movement. The channel Selector is reset to the first displayed channel if the window is moved.
Analog Output Displayed Range	Type 5788 initiates type 2131 analog read out of the 42 channels available for display in the 2131, 3o channels of which are displayed on the screen. The displayed spectrum can be read out to a level recorder, e.g. type 23o7 or an X-Y recorder e.g. type 23o8. Note: the X-Y recorder will take priority if both of the above mentioned are connected at the same time, see 2131 Instruction Manual.
Analog Output Total Range	Type 5788 initiates and controls type 2131 for an analog read out of the total analyzed spectrum of 1.41 Hz to 21.75 kHz (168 channels). On completion of a total analog read out,the 2131 display screen reverts to the "display window" being shown before this function was initiated.
Output Stop	When depressed, this function stops any read out in the process of being performed and reverts the 2131 display screen to the "display window" being shown before the read out was initiated.
Frequency Display	Indicated by the 1/12 octave center frequency selected by the Channel Selector and shown as an intensified channel column on 2131 display screen.
Display Flashing Decimal Point and Hz or kHz	Indicates that the level of the analyzed 1/12 octave frequency shown is inaccurate due to insufficient filter settling time as set on 5788 rear panel Time Delay switch.

Rear Panel Control and Sockets

Time Delay Switch Sets the settling time required by the filters between each pass to ensure accurate measurements. This delay must be set progressively longer as analysis is required to lower and lower frequencies. It is selectable according to the lowest frequency of interest, see table below.

Switch position	Lowest valid frequency
o	(for impulse measurements)
1/8 secs.	64o Hz
1 -	8o -
4 -	2o -
64 -	All filters valid

Note: Should, when the analysis is completed, the Channel Selector be set to a 1/12 octave channel where the delay was insufficient, the decimal point together with the Hz or kHz text of the 1/12 Octave Center Frequency display will flash to warn of possible measurement error.

Single Pass Trigger Input (BNC sockets) A single pass analysis will commence on receipt of a 1 kHz tone burst of ➢ 1oo mV. The tone can be obtained from 2131 reference signal.

X-Y Recorder connections

"From 2131" 8 pin DIN sockets for connection of the X staircase voltage and the Y level voltage via the 5788 to the X-Y recorder (see page 2131 Instruction Manual page 26).

"To 2308 Remote 1"	8 pin DIN socket for connection of the X deflection and pen lift control to the X-Y recorder (e.g. type 2308).
"To 2308 Y Input"	BNC socket for connection of Y level deflection to X-Y recorder (e.g. type 2308).
IEC Bus Sockets	Three sockets connected in parallel are provided for connection of devices to the IEC bus.
Mains socket	Class 2 type for connection to mains voltage as set on mains voltage selector.
Mains Voltage Selector	For selection of the correct mains voltage supply from one of the following: 100, 115, 127, 200, 220 and 240 V. The maximum allowable variation in the supply is ± 10%.
Fuse	Rating: 200 mA/200-240 V Slow 400 mA/100-127 V Slow Size Ø 5 x 20 mm

Technical Data for Type 5788

Filter Capacity: 168 6 pole filters

Bandwidth: 1/12 octave (approx. 6%)

Filter Settling Time: A five position switch can be set to a suitable position according to the lowest analyzed frequency of interest, see table below.

Switch position	Lowest valid frequency
o	(for impulse measurements)
1/8 sec.	64o Hz
1 -	8o -
4 -	2o -
64 -	All filters valid

Frequency Range: 1.41 Hz to 21.75 kHz

Dynamic Range: 6o dB

Channel Selector (5788): Controls the left & right movement of the intensified column displayed on 2131. Centre frequency is displayed on 5788, whilst selected channel is displayed on 2131 screen.

Display Window: Type 2131 displays 3o of the 168 channels as selected by 5788 "Display Window" control.

Digital Output: IEC compatible Standard Interface Bus. Interface built according to IEC proposal TC 66 (Central Office 22, for programmable measuring apparatus.) Type 5788 is a Controller function which manages the digital input and output data between interconnected devices over the IEC interface bus.

IEC Interface Function Implemented: SH 1, AH 1, T 4, L 2, DC 1, C 2 and C 28.

Analog Output (via 2131): 1) 5788 control of 2131 for output to Level Recorder Type 23o7.

	2) X-Y Recorder output X Ramp control: o to 1o V for 168 channels takes 4 times the time for 1/3 or 1/1 Octave Y Level: From 2131 via 5788.
Mains Voltage:	1oo, 115, 127, 2oo, 22o and 24o V (± 1o%) 5o-4oo Hz, ca. 2o VA, according to IEC 348 Safety Class II.
Dimension (Type A):	Height: 133 mm Width: 43o mm Depth: 32o mm
Accessories included:	Mains cable AN oo2o IEC Bus Cable AO o129
Accessories available:	BNC to BNC Cable AO oo87 DIN Cable (2 in No. are necessary for X-Y Recording) AO oo34.

Further details concerning Type 2131 and other B & K interconnected instrument can be found in the respective Instruction Manual.

Functional Notes to the User

1/3 Octave Digital Output

To transfer a 1/3 octave spectrum to a digital device via the IEC Bus:

1. Set or check that the receiving device's listener address is as specified on page 26 .
2. Press 5788 "1/3 Oct./Reset" pushbutton and wait approx. 3 seconds, see page 7 .
3. The 5788 display should read "0" to indicate output, if not, press "1/12 Oct./Stby." and then "1/3 Oct./Reset" pushbuttons. The 5788 display will now read "0".
4. Press 2131 "Digital Output" pushbutton when the required spectrum is displayed on 2131 screen.

Device Manual Controls disabled

The devices on the bus remain addressed in the 5788 "1/3 Oct." mode which could lock or disable the front panel controls of certain IEC compatable devices. To enable these manual controls the devices in this bus system must be unaddressed. This is carried out when 5788 is set to standby (Stby.) by pushing the 1/12 Oct./Stby. control.

1/3 Oct. Digital Input

To transfer 1/3 octave spectrum from a digital device (e.g. digital tape recorder) to type 2131 via the IEC bus:

1. Set or check that the transmitting device's talker address is as specified on page 26.
2. Set the talker device to the start position for data transfer with 5788 in position "1/12 Oct./Stby"
3. Press 5788 "1/3 Oct. Reset" pushbutton and wait approx. 3 seconds, see page 7 .
4. The 5788 display should read "1" to indicate input, if not, press "1/12 Oct./Stby. and the "1/3 Oct./ Reset" pushbuttons. The 5788 display will now read "1".

5. Press 2131 "Digital Input" pushbutton when the remaining 2131 controls are in their required position. The 2131 display screen will show the received data spectrum.

1/12 Octave Analysis

The 1/12 octave analysis is carried out for stationary or impulse signals as described on pages 18 to 21. However, the following points should be helpful when using type 5788.

Cable Connections

1. Connect types 2131 and 5788 as shown on page .

Power On

2. Switch power on to type 2131 first followed by type 5788. When 5788 is switched on, it automatically activates "1/3 Oct./Reset" function control which resets 2131 and any interconnected interface. (Wait approx. 3 seconds for 2131 to reset).

Select Averaging & Filter Settling Time 1/12 Octave Mode Standby State

3. Press "1/12 Oct./Stby." pushbutton to initialize the 1/12 octave mode of operation. The system is now in a standby state with pass 1 filter coefficient set and ready to continue with a 1/12 octave analysis.

4. Select the "Averaging Time" on 2131 and the filter settling time (see pages 18 & 19) on 5788.

Continuous Stationary Signal Analysis

5. a) If a continuous stationary signal is fed to the 2131 analog signal input, then press "Analysis Complete Pass" and the 1/12 octave analysis is complete when "Pass 4 completed" lamp lights.

Single Pass Analysis Manual Start

b) If each of the four passes are to be analyzed individually, e.g. due to the necessity to rewind a tape recording, then "Analysis Single Pass" must be activated. When "Pass 1 Completed" lamp lights, rewind the tape to the same starting point and press "Analysis Single Pass" and tape start simultaneously. (see page 8).

Single Pass Trigger Start

A 1 kHz tone burst recorded on the other track can be used to automatically start each single pass at a given point.

Analysis Stop

6. Should it be necessary to stop an analysis procedure before completion, press "Analysis Stop". After activating "Analysis Stop" the analysis must be started from the beginning - see re-start.

Analysis Re-start

To start another analysis, after activating "Analysis Stop", press "1/12 Oct./Stby." pushbutton first. On completion of the 1/12 octave standby function the analysis can be carried out either for Single or Complete Pass.

"Pass 4 Completed" lamp on

On completion of a 1/12 octave analysis "Pass 4 Completed" lamp lights. The 1/12 octave spectrum is stored until "Pass 4 Completed" lamp is extinguished by one of the following functions:

a) Analysis, Single Pass
b) Analysis, Complete Pass
c) Analysis Stop
d) Digital Input
e) Power Re-start

1/12 Octave Analyzing Procedure

The two types of analysis most applicable to Type 5788 in combination with Type 2131 are stationary signal and impulse analysis.

Stationary signal analysis

1. Switching Power On

When types 2131 and 5788 are to be switched on in combination with each other, ensure that 5788 is the last instrument switched on.

2. System Reset

If item 1. above cannot be ensured, then it is good practice before starting the initial analysis to press the "1/3 Oct./Reset" pushbutton thus ensuring that type 2131 has received a "System Reset" and all interface connected devices on "Interface Clear" (IFC).

3. Type 2131 Attenuator Setting

Type 2131 is now in its normal 1/3 octave mode and the attenuator must now be set so that the screen displays the highest signals possible within the signal handling capabilities of type 2131, (i.e. without overloading).

With a complex signal, e.g. pink noise, the energy is spread over four times as many channels, such that the spectrum level in 1/12 octave analysis will be lower than in 1/3 octave analysis. It is therefore important for the displayed channel levels to be as high as possible on the screen.

4. Averaging Time

Selection of "Averaging Time" can be made at this point on type 2131. Note, that the bandwidth is now a quarter of that required in 1/3 octave analysis, so that the integration time must be 4 times greater in order to obtain the same accuracy.

5. Filter Delay Time

As mentioned earlier, for every pass a new filter coefficient is automatically selected and consideration must be taken for the filter settling time.

The required settling time, with respect to the lowest analyzed frequency of interest, can be selected on a five position rear panel "Time Delay" switch, see page . This delay time ensures the filter has settled before commencing a pass analysis, i.e. averaging. It must be noted that the total analysis time (measuring time) is equal to:

$$4 \times (t_{filter} + t_{average})$$

where t_{filter} is the time delay that is selected on type 5788 rear panel and $t_{average}$ is the averaging time selected on type 2131. See type 2131 Instruction Manual page 36.

6. 1/12 Octave Analysis Start

Press the "1/12 Oct./Stby" pushbutton on type 5788 to indicate a 1/12 octave mode of operation. The 2131 display screen will not display an analysis and the system will remain in a standby mode until "Single Pass Analysis" or "Complete Pass Analysis" is activated. The "Pass Completed" lamps light as the analysis progresses.

7. 1/12 Octave Analysis Complete

On completion and indication of "Pass 4 Completed" the display and output controls of type 5788 can be activated.

Impulse signal analysis

There are several points to be considered when analyzing impulse signals.

1. Short Duration Signals

If the signals are so short that they can be recorded on a tape loop, then an automatic analysis can be made using a suitable trigger signal on the other tape track, connected to the 5788 rear panel socket "Single Pass Trigger Input".

2. Long Duration Signals

For signals of longer duration it will be necessary to rewind the tape for each analysis pass and either manually start each pass or use a trigger signal.

3. Trigger Start Availability

Depending on the pulse width it can become critical that the analysis starts at the right moment. A 1 kHz tone can be obtained using the type 2131 reference signal.

If it is not possible to record a trigger signal, then one can overcome the problem by selecting "Exp" mode and "Max. Hold". For further discussion see "Application of B & K Equipment to Frequency Analysis", chapter 3.7.3 and 4.7.2. It must be noted that the bandwidth should now be changed with a factor o.25 and the time T_A with a factor 4 in the discussion on page 183.

4. Analysis Sequence

It should be noted that "1/12 Octave Controller" Type 5788 functions in a specific sequence such that it is normally unnecessary to do anything else than start the analysis. When using the "Exp. Mode" and "Max. Hold" it is necessary to manually control type 2131 as described below.

4.1. Set filter settling time to "o" seconds on type 5788 rear panel.

4.2. Press "1/12 Oct./Stby" pushbutton on type 5788.

On completion of the switch program function (indicated by no signal display on type 2131 screen), set type 2131 in "Exp" mode.

The screen will now display the filter channel where the settling can be seen, if a short averaging time has been selected, otherwise the integration time will influence the display.

4.3. When the channel columns have fallen to the screen reference level, at least in the frequency range of interest, then a suitable averaging time can be selected.

4.4. Set type 2131 to "Max. Hold". To avoid unwanted noise activate "Hold" as soon as the result is stable on the display.

Press "Analysis Single Pass" to transmit the spectrum over to type 5788, followed by depression of "Lin" averaging on 2131.

4.5. On completion of pass 1, indicated by the respective lamp, set type 2131 to "Exp" mode and repeat steps 4.3 and 4.4. until "Pass 4 completed" lamp lights.

5. 1/12 Octave Analysis Complete

When "Pass 4 Completed" lamp lights the analysis is complete and the display and output controls of type 5788 can be activated.

Analog read-out from a Digital Frequency Analyzer Type 2131 to an X-Y Recorder Type 2308 when using 1/12 Octave Controller Type 5788 and recording paper QP 1001.

1. Connect the necessary cables as shown on page 2.
2. Press "1/3 Oct/Reset" button on 5788.

X-AXIS (Initial setting)

3. Adjust "x-zero-Set" with "Check" pressed on 2308 to position the pen at 25 Hz.
4. Press and hold both 2131 "Channel Selector" push-buttons (x-cal). At the same time adjust "X-Range" and "Gain" to position the 2308 pen at 40 kHz.
5. Release 2131 "Channel Selector" pushbuttons.

X-AXIS for 1/3 oct. from 1.6 Hz.

6. Carry out procedure in 3 to 5 above.
7. Adjust 2308 "x-zero-Set" with "Check" pressed to position the pen to 1.6 Hz.
8. Select "1.6 Hz to 1.25 kHz" on 2131 "Frequency Range". The x-axis is now calibrated for 1/3 octave readout from 1.6 Hz to 20 kHz.

X-AXIS for 1/12 oct. from 1.41 Hz.

9. Carry out procedure in 3 to 5 above.
10. Adjust "x-zero-Set" with "Check" pressed to position the pen half way between 0 and 1.6 Hz. The x-axis is now calibrated for 1/12 octave read-out from 1.41 Hz to 21.75 kHz.

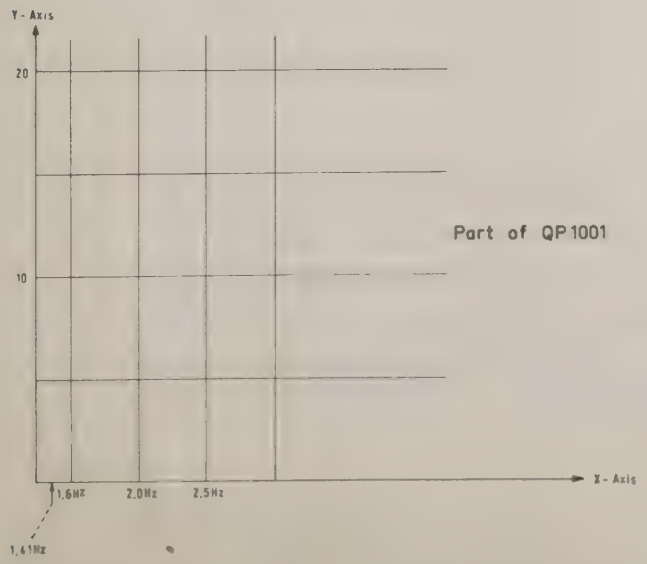
See following page.

Y-AXIS

11. Adjust 2308 "Y-zero-Set" with "Check" pressed to position the pen at the bottom line of the paper.
12. Press 2131 "Reference 100 dB uV RMS" and set 2131 "Channel Selector" to 1 kHz.
13. Adjust 2308 "Y-Range" and "Gain" to position the pen at 50 dB on the paper. (Note, this assumes 2131 is calibrated such that the reference reads 100 dB with a "Reference Adjust dB" setting of 0 dB).

The paper calibration is now completed and a readout can commence for:

a) a 1/3 oct. octave spectrum by activating 2131 "Output Control" "Analog".
b) a 1/12 oct. spectrum by first pressing 5788 "1/12 Oct/Stby." switch followed by "Analog Output - Total Range" pushbutton, if the "Pass 4 completed" lamp is ON.



Digital Data Transfer and Remote Control via The I.E.C. Interface

IEC Proposed Standard

The digital interface of 5788 is designed according to the IEC proposal "Interface for Programmable Measuring Apparatus Byte-Serial Bit Parallel" TC 66 (Central Office) 22. This standard is practically identical to IEEE standard 488-1975.

The proposed IEC standard bus interface is designed for use in digital systems in which the devices are not widely separated. The maximum cable length between all devices must not exceed 2o m and the maximum number of instruments that can be connected to one system is 15.

Basic Elements

An effective communications link requires three basic elements:

1. a device acting as a "talker" (able to transmit information to another device).
2. a device acting as a listener (able to receive information from another device.
3. a device acting as a controller (able to address devices to listen or talk, and also able to send messages to control the interface). The connections between the different devices is called the IEC Bus.

The IEC Bus

The IEC Bus consists of 16 identical lines, divided functionally into three groups. One group is used to carry data bytes and interface control messages, the second is used to control the transfer of data bytes between devices, and the third is used to "manage" the interface system.

Data Bus

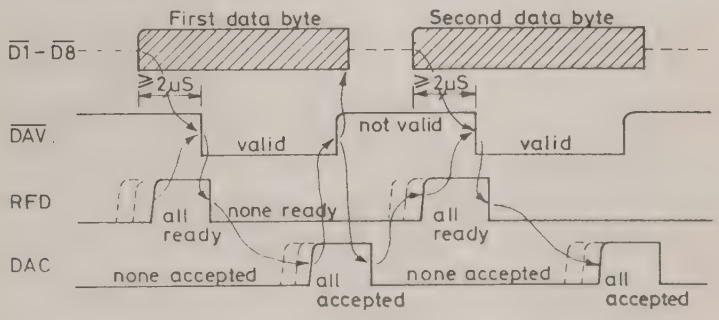
The data bus is a set of eight signal lines, designated DIO1 to DIO8 (data input/output 1 to 8) which carries the data bytes transferred between devices, and all interface control messages. Alle the information carried

on these lines is in a bit-parallel byte serial form, and is transferred asynchronously and bidirectionally.

Data Transfer Control using Handshake process

The data byte transfer control bus comprises of three signal lines, designated DAV (data valid), NRFD (not ready for data), and NDAC (not data accepted). The DAV line is used to indicate the availability and validity of information on the DIO lines. The NRFD line is used to indicate the readiness of a device (or devices) to accept data. The NDAC line is used to indicate the acceptance or non-acceptance of data by a device (or devices).

These three lines operate in a three-wire interlocked "handshake" process, meaning that a specific sequence of signals must be exchanged on these lines during transfer of a data byte. See timing sequence below.



Handshake time sequence with multiple listeners

Management Bus

The management bus comprises of five signal lines which are used to control the entire interface system. The lines are designated ATN (attention), IFC (interface clear), SRQ (service request), REN (remote enable), and EOI (end or identify). Only the three used in type 5788 controller system will be described below.

Attention (ATN)

The ATN line indicates whether the data transmitted on the DIO lines is to be interpreted as interface data (ATN true) or instrument (device) data (ATN false). The ATN signal can only be activated by the "controller in charge" (5788) which has complete control over the transmission of interface commands. In this system type 5788 is the "system controller" and "controller in charge" at all times.

Interface Clear (IFC)

The IFC signal (true) places the interface system, parts of which are contained in all interconnected devices on the IEC bus, in a known quiescent state.

End or Identify (EOI)

The EOI line is only used in this system by the addressed talker device transmitting data to indicate the end of a multiple-byte transfer sequence in conjunction with an "End of Transmission" (EOT) data byte.

General data byte transfer procedure

1. Type 5788 controller sets ATN true
2. The controller sends the "unlisten" (UNL) command, which inhibits all current listener devices, over the DIO lines.
3. The controller sends over the DIO lines the address of the listener device which is to receive the data. More than one address can be sent consecutively if more than one device is to receive the same data. See page 26 for device addresses.
4. The controller sends the address of the talker device which is to send the data to the listener or listeners. The addressed talker device is able to send data as soon as ATN is set false. See page 26 for device addresses.
5. The controller sets ATN false. Serial data bytes are then transferred on the DIO lines from the currently enabled talker to alle currently enabled listeners. Data can be sent until

the controller again sets ATN true. In a system using type 5788 a talker indicates completion of a multiple byte transfer sequence by setting EOI true while sending the last byte which must be EOT (end of transmission). See below.

bit No.	8	7	6	5	4	3	2	1
EOT byte	0	0	0	0	0	1	0	0

Type 5788 IEC Interface capability.

The following specification is with reference to proposed standard 66(Central Office)22 pages 107 to 111.

Function	Designation	Capability
Source handshake	SH 1	Complete capability
Acceptor handshake	AH 1	Complete capability
Talker function	T 4	Basic talker - yes Serial pole - no Talk only - no Unaddress if MLA- no
Listener function	L 2	Basic listener - yes Listen only - no Unaddress if MTA-no
Service Request	SR 0	None
Remote / Local	RL 0	None
Parallel Pole	PP 0	None
Device Clear	DC 1	Complete capability
Device Trigger	DT 0	None
Controller	C2 & C28	C2: System controller - yes Send IFC & take charge-yes Send REN - no C28 Respond to SRQ - no C28: Send IF messages - yes Receive control - no Pass control - no Parallel pole - no Take charge synchr.- no

Device Addresses.

In an IEC bus system each device has a listener and / or talker address depending on its function. Devices with both data and program/status communications require two addresses to distinguish between the two modes. The least significant bit is usually used for this purpose.

The bit configuration for transmission and reception is :

```
bit - 8 7 6 5 4 3 2 1
      0 0 1 X X X X X   Listener address (LAD)

      0 1 0 X X X X X   Talker address (TAD)
```

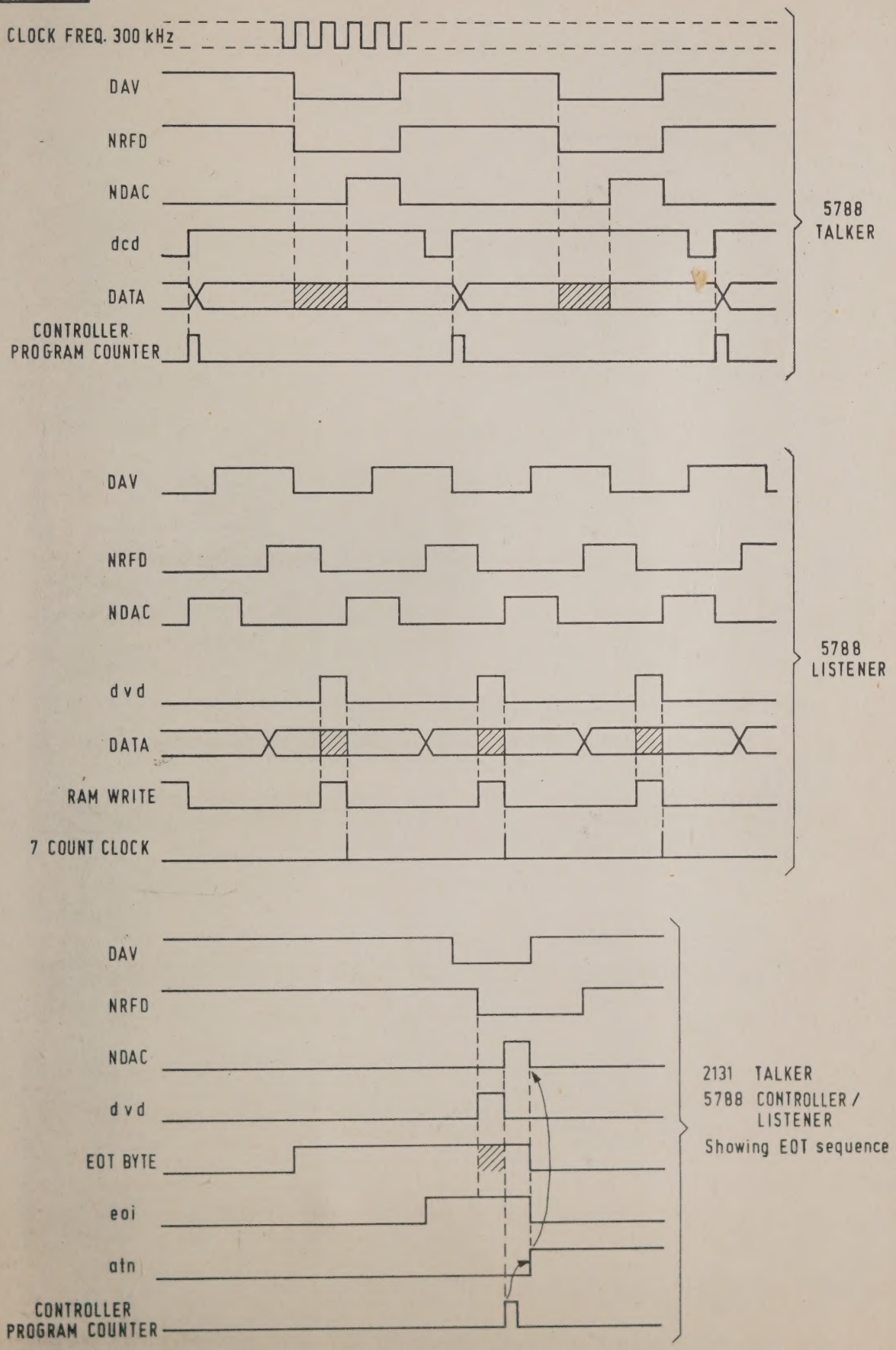
Bits 1 to 5 are the device dependent codes of the device listen and talker address.

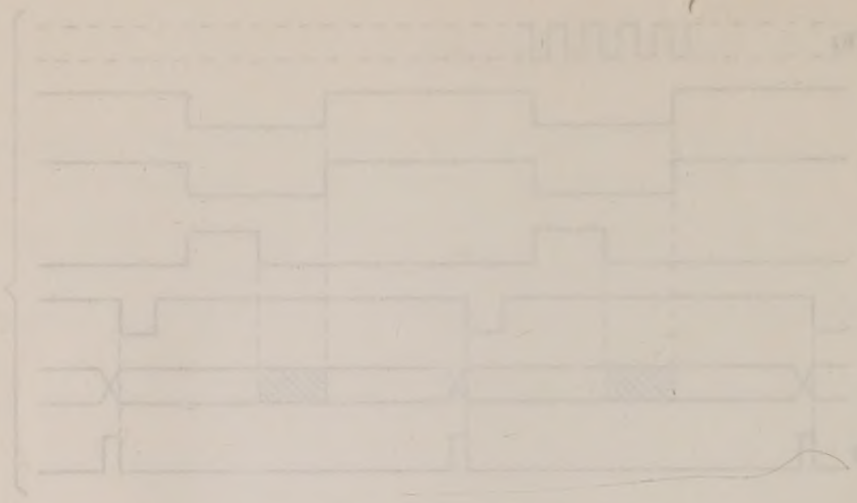
The following address codes are used by Controller Type 5788 and therefore each device must be coded with respect to the following functions it has to perform.

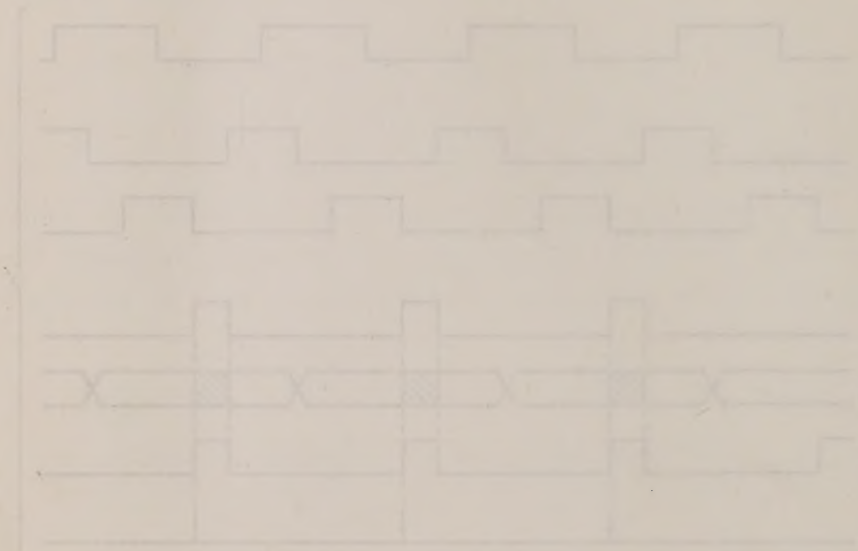
	Data TAD/LAD bit- 5 4 3 2 1		Status TAD/LAD bit- 5 4 3 2 1	
Type/Function				
5788.....	1 0 0 1 0	.....	1 0 0 1 0	factory set
2131.....	1 0 0 0 0	.....	1 0 0 0 1	factory set
Digital Input/ Output Device Address.....	0 1 1 1 0	.....	0 1 1 1 1	
Digital Output..... (e.g. type 2312)	0 1 0 0 0	.....	None	

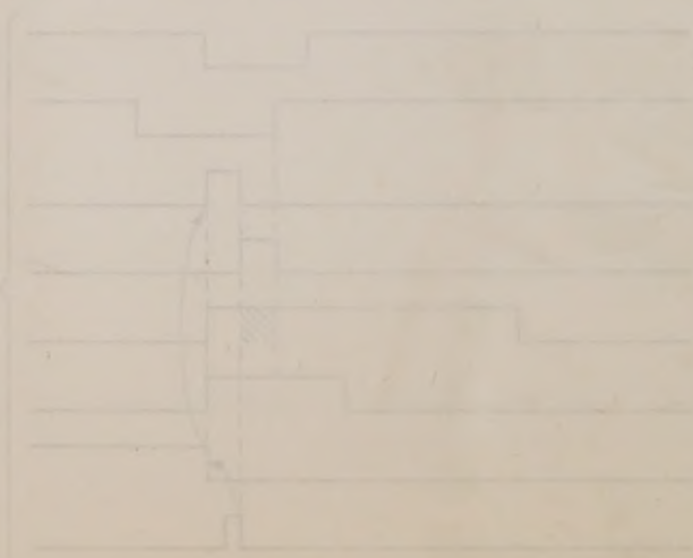
Note: Type 2312 "Control Clock Selector" must be set to position "Ext".

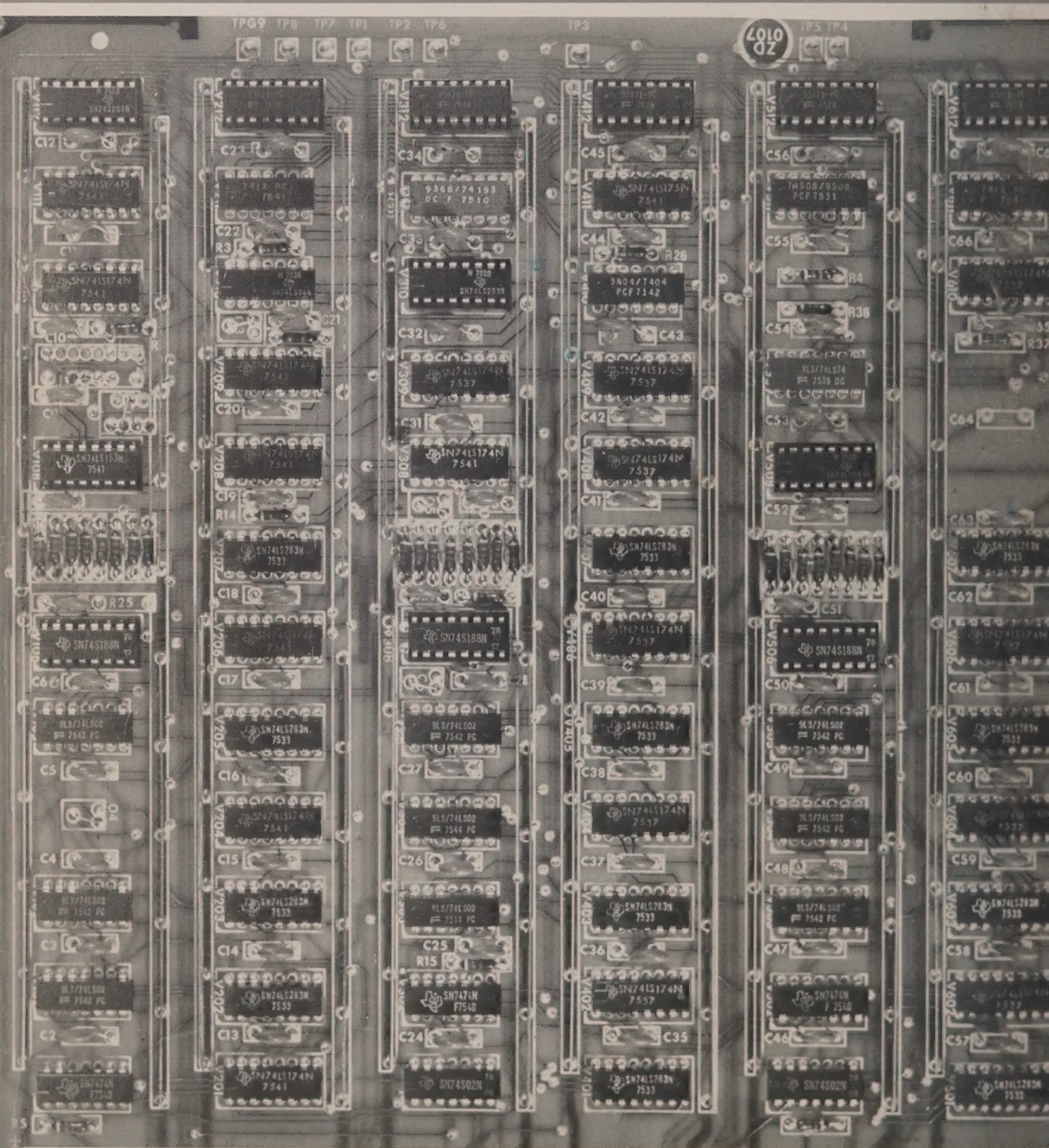
Timing Sequence.











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